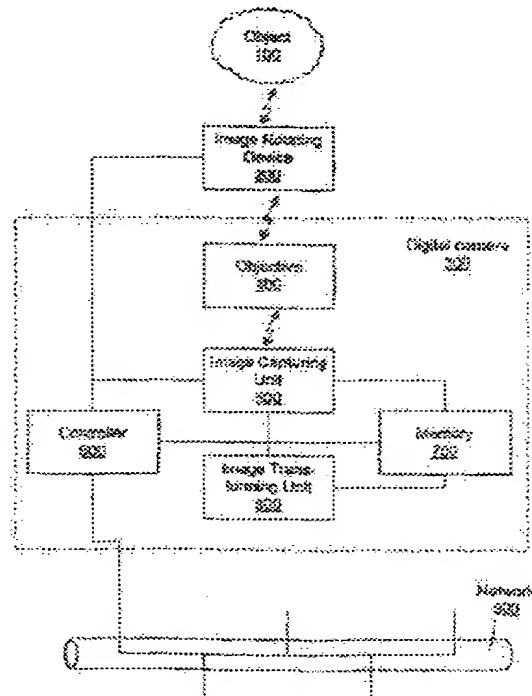




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification: <b>G03B 37/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 00/57246</b> (43) International Publication Date: 28 September 2000 (28.09.00)
(21) International Application Number: <b>PCT/SE00/00522</b> (22) International Filing Date: <b>17 March 2000 (17.03.00)</b> (30) Priority Data: <b>9801038-1</b> <b>19 March 1999 (19.03.99)</b> <b>SE</b> (71) Applicant (for all designated States except US): <b>AXIS AB</b> <b>[SE/SE]; Söderlångavägen 16, S-223 70 Lund (SE).</b> (72) Inventor; and (75) Inventor/Applicant (for US only): <b>SÄGEFALK, Willy</b> <b>[SE/SE]; Möllevägsvägen 8, S-222 40 Lund (SE).</b> <b>ABRAHAMSSON, Lars [SE/SE]; Vidögatan 1B, S-582 46 Linköping (SE).</b> (74) Agents: <b>STRÖM, Torc et al; Ström &amp; Gulliksson AB, P.O.</b> <b>Box 4188, S-200 13 Malmö (SE).</b>	(81) Designated States: <b>AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GH, GR, GU, HK, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GR, GU, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</b>  Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	
(54) Title: <b>A DIGITAL CAMERA HAVING PANNING AND/OR TILTING FUNCTIONALITY, AND AN IMAGE ROTATING DEVICE FOR SUCH A CAMERA.</b>		
(57) Abstract:  A digital camera (200) has panning and/or tilting functionality and comprises: a camera housing (5) with an optical input (400), such as a lens or objective (8), an image capturing unit (500) for producing a digital image from light received through the optical input; and a controller (600). A first mirror (9) is mounted externally to the camera housing (5). An image rotating device (200) receives an angular displacement control signal from the controller (600) and rotates the first mirror at an angle with respect to the optical input (400, 8) of the camera housing (5).		



*FOR THE PURPOSES OF INFORMATION ONLY*

*Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.*

AL	Albania	EE	Estonia	LB	Lebanon	SE	Senegal
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Ghana	LV	Latvia	SS	Romania
AX	Andorra	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TO	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TY	Tajikistan
BE	Belgium	GN	Guinea	MR	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	MT	Malta	TR	Turkey
BG	Bulgaria	HU	Hungary	MM	Myanmar	TV	Tuvalu and Tokelau
BI	Burundi	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MY	Malaysia	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	VE	Venezuela
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NI	Nicaragua	YE	Yemen
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Cote d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CN	China	KR	Republic of Korea	PS	Palestine		
CO	Colombia	KZ	Kazakhstan	PT	Portugal		
CZ	Czech Republic	LA	Laos	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
		LR	Liberia	SG	Singapore		

A DIGITAL CAMERA HAVING PANNING AND/OR TILTING  
FUNCTIONALITY, AND AN IMAGE ROTATING DEVICE FOR SUCH A  
CAMERA

5        Technical Field

The present invention relates to a digital camera  
having panning and/or tilting functionality, and more  
specifically to a digital camera having a camera housing  
with an optical input, such as a lens or objective, an  
10    image capturing unit and a controller. The invention also  
relates to an image rotating device for providing the  
panning and/or tilting functionality of such a digital  
camera.

15       Background Art

A common example of a digital camera with panning  
and/or tilting functionality is a web camera, which e.g.  
may be mounted at a given location for the purpose of  
surveillance, production monitoring, etc. The web camera  
20    comprises an optical input in the form of a lens or  
objective and an image capturing unit for producing a  
digital image from light received from the optical input.  
Usually, the image capturing unit comprises a CCD element  
(Charge Coupled Device). The web camera has software and  
25    hardware for allowing the camera to be connected to a given  
network, such as an Ethernet or Token Ring network. The web  
camera is arranged to produce digital images at a given  
rate, such as 1-25 images per second. In order to increase  
the visual volume covered by the web camera, the camera is  
30    provided with mechanical means for panning and/or tilting  
the camera. Generally speaking, "panning" means rotating  
the camera by a given angle (normally 0°-360°) in a  
horizontal plane, and "tilting" means rotating the camera  
by a given angle (normally 0°-180°) in a vertical plane.

35       In prior art web cameras the panning and/or tilting  
functionality is obtained by moving the whole camera or at

least the objective thereof. Since the camera and objective have a considerable weight, such an approach involves complex, large and expensive mechanics. Furthermore, the speed at which the camera may be panned or tilted is restricted due to the large mass, that has to be moved accordingly.

#### Summary

It is an object of the present invention to provide a digital camera, which allows faster and more accurate panning and/or tilting, thereby allowing the camera to produce more images per time unit. Furthermore, it is an object of the present invention to provide an image rotating device, to be mounted externally to the digital camera, for providing efficient and rapid panning and/or tilting functionality, without requiring large or expensive mechanics.

The above objects are achieved by providing the digital camera with an image rotating device having a mirror mounted externally to the camera housing and having a rotational member for rotating the mirror with respect to the optical input (lens or objective) of the camera housing in response to an angular displacement control signal received from a controller of the digital camera.

Other objects, features and advantages of the present invention will appear from the following detailed disclosure, from the appended claims as well as from the drawings.

#### Brief Description of the Drawings

A preferred embodiment of the present invention will now be described in more detail, reference being made to the accompanying drawings, in which:

FIG 1 is a schematic block diagram of the overall structure of a digital camera according to the preferred embodiment.

FIG 2 is a first sideview of the image rotating device and the camera, to which it is mounted.

FIG 3 is a second sideview of the image rotating device and the camera shown in FIG 2, and

FIG 4 is a topview of the image rotating device shown in FIGS 2 and 3.

#### Detailed Disclosure

Referring to FIG 1, a digital camera 300 is illustrated in a basic modular form. The digital camera 300 is arranged to produce one or several digital image(s) of a generic object 100, which may be any physical object that is present in a volume optically covered by the digital camera 300. An inventive image rotating device 200 is mounted externally to the digital camera 300 in front of an optical input 400 of the digital camera. The optical input 400 is a generally known lens or objective. The purpose of the image rotating device 200 is to extend the available field of view of the digital camera 300 in at least one plane, preferably in a horizontal plane as well as in a vertical plane. A preferred embodiment of the image rotating device 200 will be described in more detail with reference to FIGS 2-4.

As shown in FIG 1, the digital camera 300 further comprises an image capturing unit 500, which is provided with appropriate means for producing a digital image representative of the object 100. Preferably, the image capturing unit 500 comprises a CCD element (Charge Coupled Device), the internal structure of which is believed to be well-known to a man skilled in the art. The digital camera 300 also has a controller 600 for controlling the image capturing unit 500 as well as the external image rotating

device 200. The controller 600 is operatively connected not only to the device 200 and the unit 500 but also to a digital memory 700 for storing images captured by the image capturing unit 500. Furthermore, the digital camera 300 may comprise an image transforming unit 800, the purpose of which is to rotate the digital image to compensate for image rotating effects caused by the image rotating device 200, when the field of view is panned or tilted. The image transforming unit 800 is responsive to an angle of rotation of the image rotating device 200 with respect to the objective 400 and uses this angle of rotation when transforming the digital image to compensate for the current pan and/or tilt angle. To perform such image transforming, i.e. to rotate a digital image in one or more than one direction, is believed to be well within reach of a man skilled in the art of digital cameras. Therefore, the internal structure of the image transforming unit 800 will not be described herein.

The memory 700 may be implemented by any commercially available memory, such as an EEPROM memory.

As indicated in FIG 1, the digital camera 300 may be connected to a network 900, such as an Ethernet or Token Ring network, which in turn may be part of the Internet. In such an application, the controller 600 of the digital camera 300 is provided with appropriate software for allowing the digital camera 300 to act as a web camera available on the network 900, i.e. a web server that produces digital images.

The pan and/or tilt angle of the digital camera 300, or more specifically the angle(s) by which the image rotating device changes the field of view of the camera 300 with respect to a central axis of the objective 400, may be set and changed by a user of the camera by accessing the controller 600 through the network 900. Alternatively, the

pan and/or tilt angle(s) may be controlled from a computer directly connected to the digital camera 300.

A preferred embodiment of the image rotating device 200 will now be described in more detail with reference to FIGs 2-4. The following elements are shown in these drawings:

Qty	Ref. No.	Name
1	19	Frame
1	18	Timing belt tightener
1	17	Belt wheel
1	16	Timing belt
1	15	Belt wheel
1	14	Timing belt
1	13	Timing belt tightener
2	12	Optical sensor
1	11	Mirror holder
1	10	Tilting mirror
1	9	Fixed mirror
1	8	Camera lens (objective)
2	7	Motor
1	6	Camera housing
1	5	Mirror wheel
1	4	Bevel gear
1	3	Tilt shaft
2	2	Fixing part
1	1	Guiding wheel

The image rotating device 200 has a mirror system, comprising a first fixed mirror 9 and a second tilting mirror 10. The fixed mirror 9 is mounted directly in front of the objective 8 at an angle of 37° relative to the

optical center axis of the camera 300. The fixed mirror 9 is mounted to a mirror wheel 5, which is rotatable around the objective and hence provides a field of view with an angle of rotation of between 0° and 360°.

5 In the center of the field of view the tilting mirror 10 is mounted, so that the axis of rotation thereof is perpendicular to the optical center axis of the camera. The tilting mirror 10 is carried on the mirror wheel 5, thereby causing the tilting mirror 10 to rotate around the objective 8 together with the fixed mirror 9. Thanks to the geometrical arrangement of the mirrors 9 and 10 with respect to the objective 8, it is possible to monitor a large volume in a short time.

The tilting mirror 10 is attached to a mirror holder 11, which in turn is journaled in the mirror wheel 5 between two fixing parts 2. Opposite to the mirror wheel 5 a slightly smaller guiding wheel 1 is concentrically mounted. A tilt shaft 3 is eccentrically mounted to the mirror wheel, so as to cause the tilting mirror 10 to move. 15 The guiding wheel 1 transmits its motion to the tilt shaft 3 and from the tilt shaft 3 through a bevel gear 4 to the mirror holder 11. The arrangement resembles a planetary gear, where the guiding wheel represents a sun pinion and the tilt shaft represents a planet pinion. The mirror wheel acts as holder of the planet pinion.

When the mirror wheel does not move, if the guiding wheel is rotated, the tilt shaft 3 will rotate around its own axis, wherein the mirror holder 11 will be rotated around its axis of rotation. Hence, the tilting mirror 10 20 is rotated with respect to the mirror wheel 5, and the center axis of the field of view will be angled with respect to the optical center of the camera. If the mirror wheel 5 and the guiding wheel 1 rotates at the same angular velocity, there will be no relative motion in the tilt shaft and consequently no rotation of the mirror 25



holder/mirror around its axis of rotation. However, the mirror wheel 5 as a whole will rotate with the fixed mirror 9 and the tilting mirror 10 at a constant angle to the optical center axis of the camera.

3 In other words, by rotating the mirror wheel 5 and the guiding wheel 1 synchronously, the field of view may be rotated 360° for any given tilt angle. Then, if the wheels are rotated relative to each other, the angle of the mirror holder 11 will change, and the field of view may be again  
10 be rotated 360° for a new tilt angle. In this way, a very large volume around the camera may be covered, and images may be obtained for any given location within this large volume.

The mirror wheel 5 and the guiding wheel 1 are driven  
15 by respective motors 7. Belt wheels 15, 17, timing belts 14, 16 and timing belt tighteners 13, 18 are provided, as shown in FIGs 3-4.

The inventive image rotating device provides at least the following advantages:

- 20
- \* Low moment of inertia for rotating parts
  - \* High pan/tilt adjustment speed, short time between angular settings
  - \* High setting accuracy
  - \* Compact design
  - 25 \* Few structural components
  - \* Low manufacturing cost
  - \* Flexible design
  - \* Simple pan/tilt control
  - \* Wide field of view

30 The present invention has been described above with reference to a preferred embodiment. However, other embodiments than the one disclosed herein are possible within the scope of the invention, as defined by the appended independent patent claims.

## CLAIMS

1. A digital camera (300) having panning and/or tilting functionality, comprising: a camera housing (6) with an optical input (400), such as a lens or objective (8); an image capturing unit (500) for producing a digital image from light received through the optical input; a controller (600); a first mirror (9) mounted externally to the camera housing (6); and an image rotating device (200), which is connected to the controller (600) and is adapted to rotate the first mirror at an angle of rotation with respect to the optical input (400, 8) of the camera housing (6), characterized by

an image transforming unit (800), which is connected to the image capturing unit (500) and is adapted to rotate the digital image, as captured by the image capturing unit (500), by an angle related to the angle of rotation of the first mirror (9).

2. A digital camera as in claim 1, further comprising a second mirror (10) mounted externally to the camera housing (6), wherein the image rotating device (200) is adapted to rotate the second mirror at a second angle of rotation with respect to the optical input (400, 8) of the camera housing (6).

3. An image rotating device (200) for a digital camera (300) having a camera housing (6), an optical input (400), such as a lens or objective (8), and an image capturing unit (500) for producing a digital image from light received through the optical input, the image rotating device comprising a first mirror (9) mounted externally to the camera housing (6), and a first rotational member (5, 7) for rotating the first mirror at a first angle of

rotation with respect to the optical input (400, 8) of the camera housing, characterized by

a second mirror (10) mounted externally to the camera housing (6); and

- 5 a second rotational member (3, 7) for rotating the second mirror at a second angle of rotation with respect to the optical input (400, 8) of the camera housing.

1/4

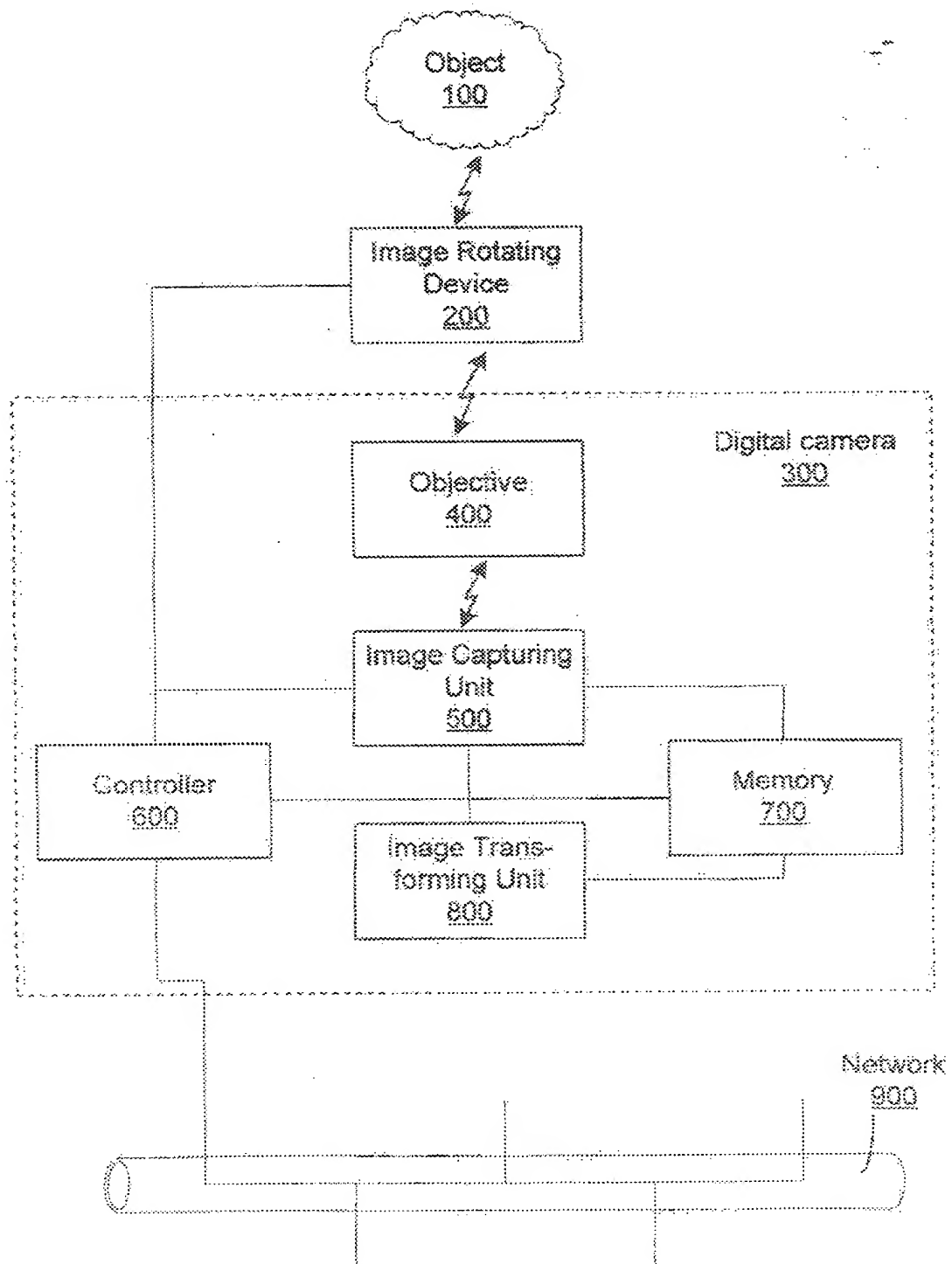


FIG 1

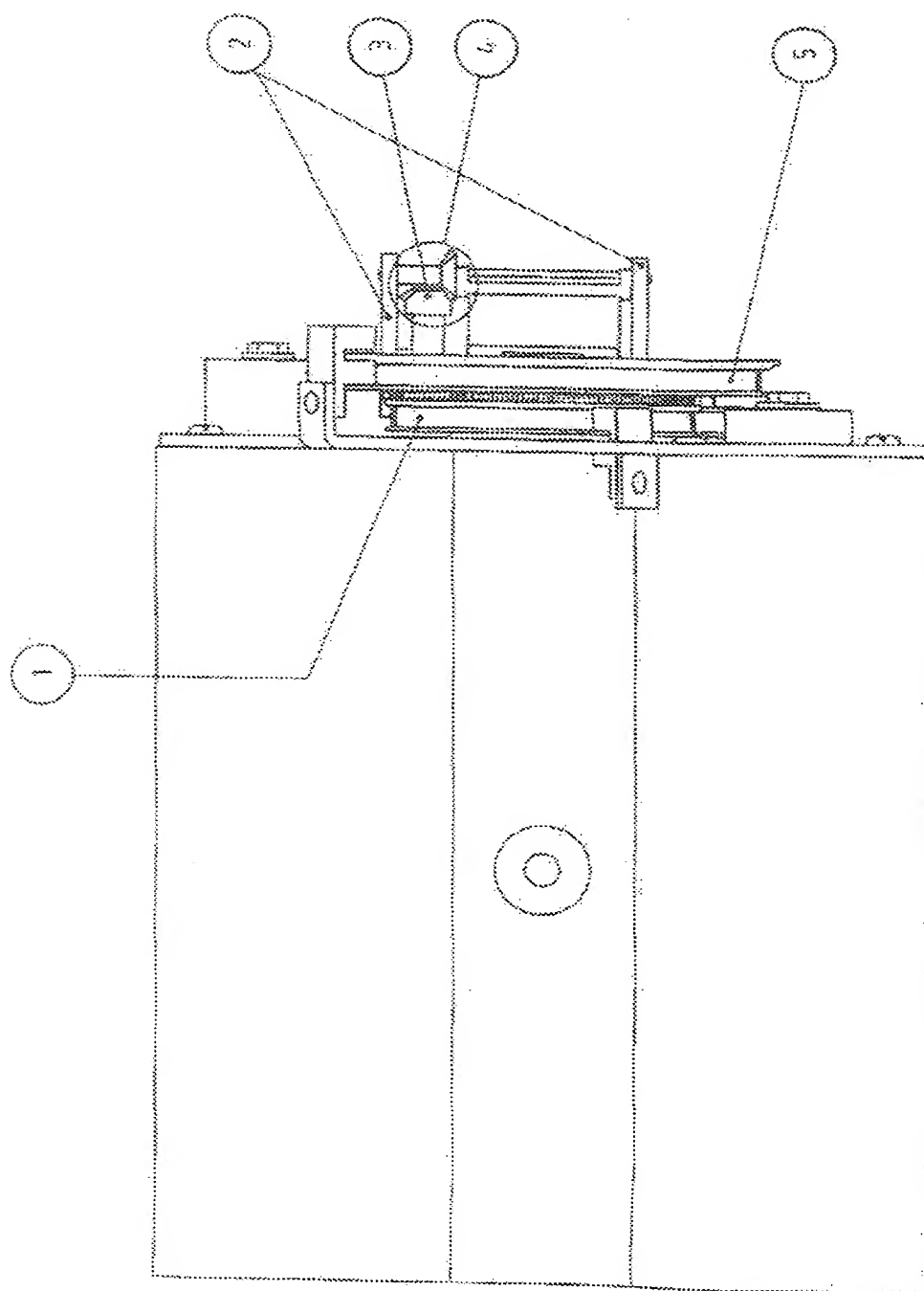
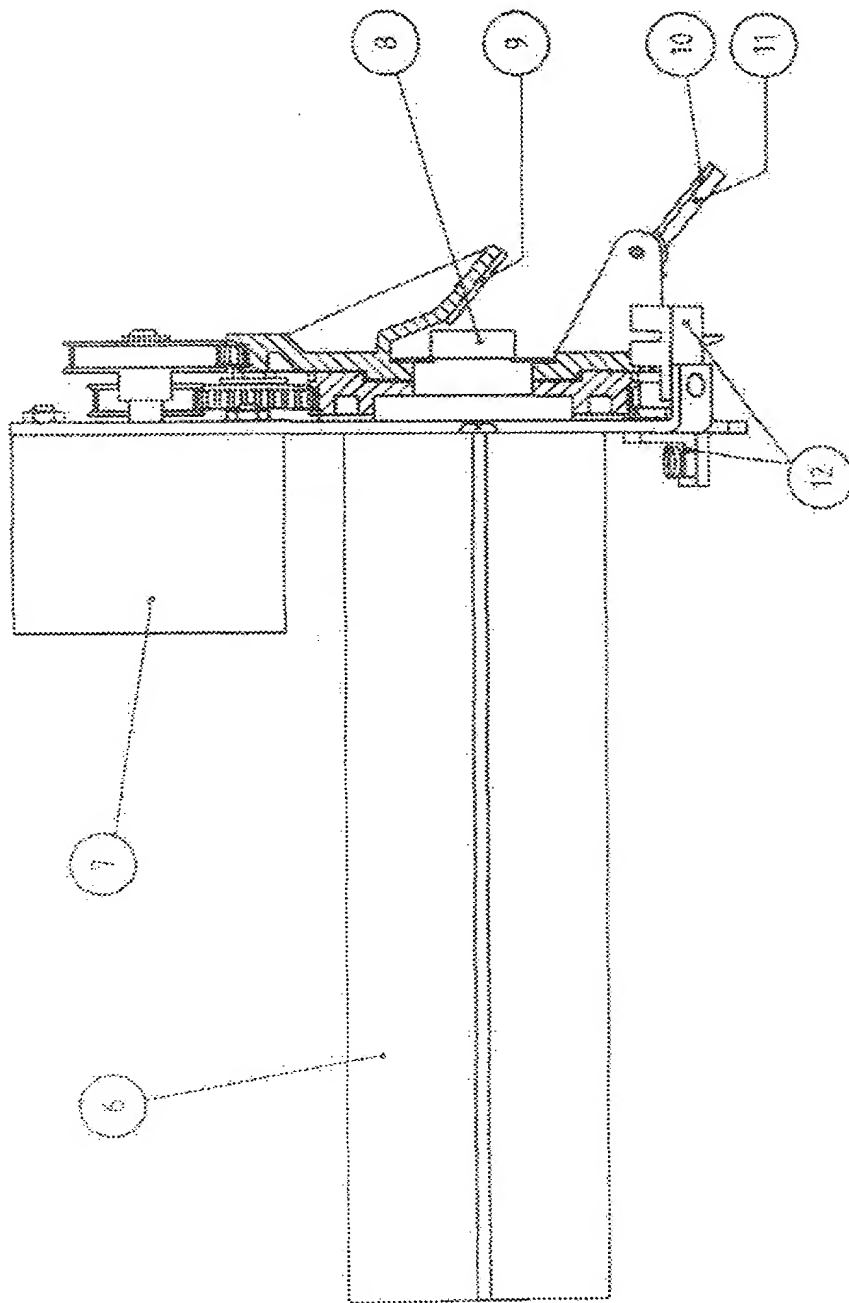


FIG 2

3/4



4/4

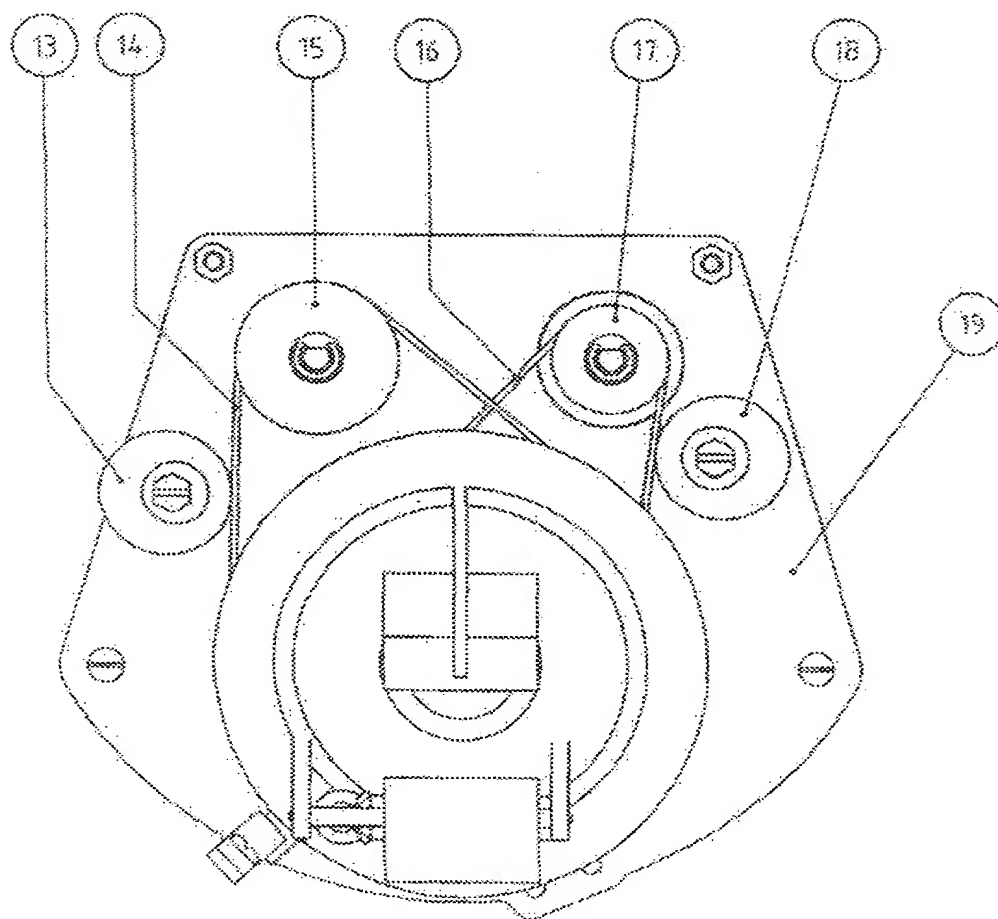


FIG 4

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 00/00522

A. CLASSIFICATION OF SUBJECT MATTER		
IPC7: G03B 37/00 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC7: G03B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,OK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
WPI, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5717512 A (CHMIELEWSKI, JR. ET AL), 10 February 1998 (10.02.98)	1-3
A	US 3868706 A (STEINGOLD), 25 February 1975 (25.02.75)	1-3
A	US 4499490 A (MORGAN), 12 February 1985 (12.02.85)	1-3
A	US 5606368 A (CORRADINI), 25 February 1997 (25.02.97)	1-3
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
<p>* Special categories of cited documents</p> <p>"A" documents defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier documents not published on or after the international filing date</p> <p>"I" documents which may throw doubt on priority claimed or which is cited to establish the prior art state of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" documents published prior to the international filing date but later than the priority date claimed</p> <p>"X" later document published after the international filing date or priority date and not in conflict with the application but which is understood to be the principle or theory underlying the invention</p> <p>"Y" document of particular relevance the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Z" document of particular relevance the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>		
Date of the actual completion of the international search		Date of mailing of the international search report
3 July 2000		18-07-2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 85		Authorized officer Björn Kallstenius / JA A Telephone No. +46 8 782 25 00



INTERNATIONAL SEARCH REPORT  
Information on patent family members

02/12/99

International application No.

PCT/SE 00/00522

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5717512 A	10/02/98	AU 3006297 A WO 9743677 A	05/12/97 20/11/97
US 3868706 A	25/02/75	NONE	
US 4499490 A	12/02/85	NONE	
US 5606368 A	25/02/97	NONE	

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**